Title: Good Days, Bad Days

Link to Outcomes:

- **Problem Solving** Students will develop a mathematical model for a real-life topic.

- **Reasoning** Students will analyze and interpret information from graphs and tables.

- **Patterns and Functions** Students will use trigonometric functions to model real-life situations.

- **Technology** Student will use graphing calculators to graph and interpret biorhythms.

- **Communication** Students will express their findings orally during class discussion and in written responses to questions when they defend their answer choices.

- **Connections** Students will connect trigonometric graphs with real-life physiology.

Brief Overview:

Biorhythm theory asserts that we all have cyclic inner rhythms which begin at birth. These rhythms follow a sinusoidal pattern and we can determine "good" and "bad" days for certain activities by examining high and low points on a sine curve.

Using trigonometric functions, each student will determine his/her own set of biorhythms.

Grade/Level:

Grades 11-12; Trigonometry, Pre-calculus.

Duration/Length:

This lesson will take approximately 2 days.

Prerequisite Knowledge:

Students should have graphed trigonometric functions and should be familiar with determining phase shifts and periods for these functions.

Objectives:

- Students will be able to graph trigonometric functions on a graphing calculator.
- Students will be able to determine equations for their own biorhythms.
- Students will be able to interpret results in order to predict "good" and "bad" days, based on their biorhythm graphs.

Materials/Resources/Printed Materials:

- Graphing calculator
- Worksheet 1 - Good Days, Bad Days
- Worksheet 2 - Questions

Development/Procedures:

Class discussion will begin with an introductory resource sheet, titled "Good Days, Bad Days."

Teachers will then assist students in determining the starting point of their most recent cycle. Each student will calculate the number of days that he/she has been alive. Using the remainder to determine their current position in a cycle, students will sketch a graph (on paper) based on starting point and period. Students will write an equation that describes this sketch.

Working independently, students will sketch their other two biorhythms and determine the equations.

Have students answer questions on Worksheet 2. For questions 5–7, use of graphing calculator should be emphasized.

Evaluation:

Students will hand in 3 items: a written response in paragraph form to question 7, a sketch of their physical, intellectual, and emotional biorhythms on the same grid, and the trigonometric equations of their biorhythms.

Extension/Follow Up:

Challenge students to find cosine equations to describe each of their biorhythms.

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Worksheet 1: Good Days, Bad Days

According to a theory called biorhythms, each person has three internal rhythms that begin at birth. These include a physical cycle, an emotional cycle, and an intellectual cycle. Each cycle consists of a high period, a low period, and a transition day when a person moves from one period to the other. These three cycles can be graphed together so that a person can determine in advance when **"good" and "bad" days** will occur. (Refer to Scott, Foresman, *Trigonometry*, 1983.)

Your task is to find your own biorhythm patterns, in order to determine your **good days and bad days**. This will require you to utilize your knowledge of the trigonometric functions and their graphs.
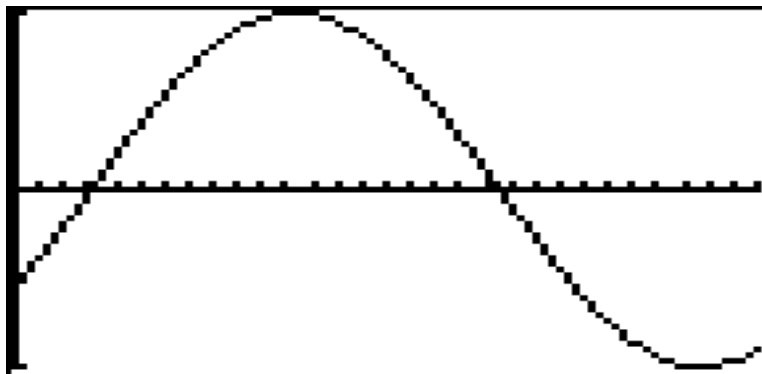
Examine the biorhythm graph for the month of September pictured below. (Graph 1).

Label biorythms.

        Physical: period __
     Emotional: period __
    Intellectual: period __
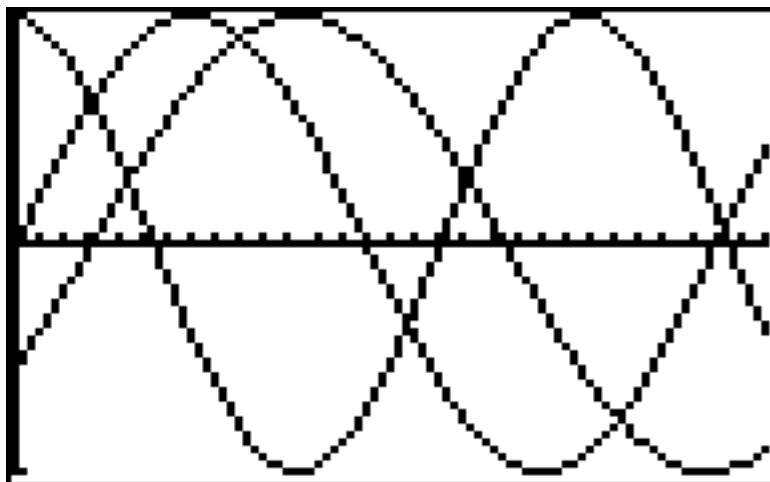
Examine the intellectual biorhythm for September taken from the graph above. (Graph 2).

What is the equation for this sine graph?

Worksheet 2: Questions

Part I
Answer the following questions according to your graphs.

1. What are good days for you to perform physical activities?

2. What are the transition days for your emotional cycle?

3. Which day would you prefer to take your Trigonometry test?

4. Which would be the worst possible day for you to try-out for the Olympics?

Part II

5. Was December 20th a good day for you emotionally? Justify your answer.

6. Was August 1st a good or bad day emotionally for you? Justify your answer.

7. Determine a set of days within the next two months that should be **"BANNER DAYS"** for you.

> Your response to these questions should be in paragraph form, and include your explanation for how and why you chose your "Banner Days." You will be expected to turn in your paragraph, a copy of your graphs, and the equations for each of your own biorhythms.

Teacher Notes for Worksheet 1

The lesson should begin with the introductory information found on the worksheet.

Discuss Graph 1. Of the three biorhythm graphs, have students focus on the intellectual biorhythm, which is the graph that intersects the x-axis at 3. Have students highlight this curve and label the other two graphs. The emotional cycle begins at the origin and the physical cycle begins at 5 on the graph. The intellectual cycle has a period of 33 days, physical is 23 days, and emotional is 28 days.

Discuss the x- and y-axes. The x-axis represents each day, starting with the first day of the month. The y-axis indicates the amplitude of the sine graphs, which in this situation, is arbitrary.

The following discussion questions are suggested, to check student understanding of the graph.

- What days would be "good days," intellectually? How can you tell?

- What day in the month would be the worst day emotionally? How can you tell?

- How many days are in one full cycle of the physical cycle?

Graph 2 shows the graph of the intellectual biorhythm separately. Ask students to write the equation for this sine graph. Encourage students to work with a partner to determine the equation of the sine curve. It may be helpful to remind students to consider what they know about period and phase shift. The equation is $y = \sin [2\pi/33 (x - 3)]$.

Assist students in making a rough sketch of their own intellectual biorhythm, and in determining its equation.

In order to figure out where they are currently in their cycle, they must calculate the total number of days that they have lived. Remember to include Leap years and days since last birthday.
> For example:
> > Today's date: May 30, 1995
> > Birthdate: April 14, 1978

Days lived = age * 365 + number of Leap Years + number of days since birthday

Days lived = 16*365 + 4 + 16 = 5860

$$\frac{5860 \text{ (days lived)}}{33 \text{ (days in cycle)}} = 177 \text{ complete cycles} + 19 \text{ days}$$

Therefore, the latest cycle began May 11th (19 days from today's date May 30th)

So the curve can be sketched using a period of 33 days, and a phase shift of 11.

$y = \sin [(2\pi/33)(x - 11)]$

Using the data from one student or a celebrity, etc., have all students determine the equation for one of the cycles. Then have students calculate the number of days that they have lived and find the equations for their own biorhythms. It is suggested that they sketch the graph of each biorhythm, which should help in determining the phase shift.

Teacher Notes for Worksheet 2

Questions 1 through 4 are intended to help students interpret their graphs, and to provide time for the teacher to check student progress. Answers will vary, but the method for finding the response should be similar and can be discussed.

On question 5, the teacher should facilitate a discussion about how to count days, as a continuation from month to month. For example, if November 1 is day 1, then December 1 is day 31. Some students may suggest extending their sketch on paper, but guide the discussion so that students realize the advantage of using the graphing calculator. To view a point in time in the future or in the past, students can adjust the x scale in windows.

Question 7 serves as the final analysis of biorhythms, and as the completion of the project. If computers and GraphLink are available, students may print out their graphs from their graphing calculator screen. If these tools are not available, then ask students to draw a sketch of the relevant portion of their graph which justifies their answer. Also have students write down their equations that they have entered into y=. Finally, students should write a complete paragraph that includes the justification of how they determined their **"Banner Days."**

Students may use various techniques to determine their Banner Days. (i.e., when the combination of the three cycles is as good as possible). They may:

a. sketch additional cycles all on one graph.
b. use graphing calculator to view future months.
c. use tables to examine numeric values to determine when function values are closest to 1.
d. add the three functions and look for the maximum value.